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DESCRIPTION

OF

TAYLOR'S PATENT PHOTOMETER,

FOR

ESTIMATING PHOTOGRAPHIC EXPOSURES,

WITH INSTRUCTIONS FOR USE.

PATENTED MARCH 24TH, 1885. No. 3,755.

SOLE LICENSEE—CHAS. COPPOCK, 100, NEW BOND STREET, LONDON, W.

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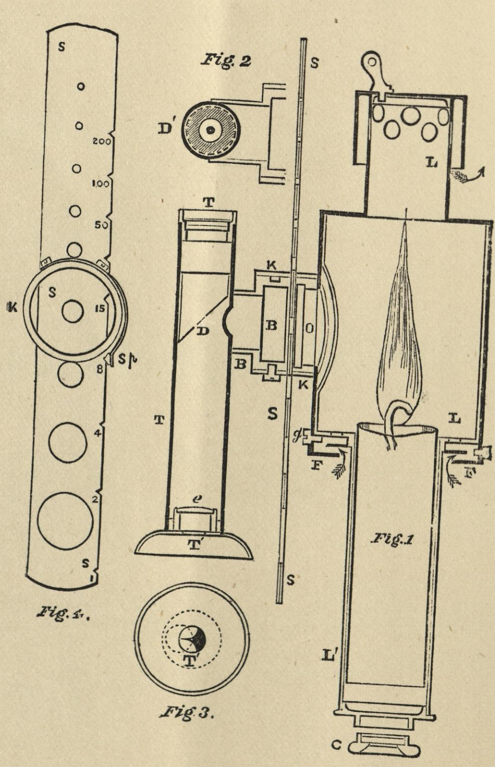

Fig. 4.

Fig. 3.

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INSTRUCTIONS

FOR USING

TAYLOR'S PATENT PHOTOMETER,

FOR ESTIMATING PHOTOGRAPHIC EXPOSURES.

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BEFORE using the Photometer the following instructions should be read through carefully. The principle of the instrument will be first explained by the aid of the diagram, in which it is represented exactly half its real size.

Fig. 1 is a vertical section through the instrument. L L L is a lamp, consisting of a tube L, to hold a standard sperm candle, and a body with a chimney on the top. The inlet and outlet holes which allow air to pass to and from the flame are so shielded that daylight cannot penetrate into the lamp to any injurious extent. It is practically light tight. The body of the lamp consists of an outer and an inner casing, the inner casing forming one piece with the candle tube; thus, by grasping the candle tube, the inner casing can be turned round within the outer casing. The outer casing has two openings cut out in it, one being shewn at O and the other in a position at rightangles to it; the inner casing has one opening, which can be made to coincide with either of the two openings in the outer casing. In one case an opening is presented through which the candle can be lighted, and in the other case the lamp is closed up, but a clear way is left for the candle light to fall upon and illuminate the opal glass disc O, which is carried within the short tube K, fixed to the outer casing. A hollow socket B rotates stiffly within K and carries, fixed at rightangles to it, the observing tube T T′. Closely in front of the opal disc O there slides the diaphragm—slide S S, perforated with a graduated series of apertures.

Where the light from the illuminated disc O shines into the tube T T′, is placed a thin diagonal metal diaphragm D. This is perforated with a small oval hole in its centre, which is

surrounded by a white ring. At T′ is the eye-piece, carrying a lens *(e)*, which enables the eye, placed at T′, to see the hole in D with distinctness. The other end T of the tube carries a combination of coloured glass; its purpose being to only allow those rays of light to pass through, to which the photographic plate is sensitive. Fig. 3 is an end view of the eye-piece. The clear opening is represented as a black V shaped mark. The reason for this shape will be given further on. If the lamp is held upright, it follows from the connection between the tube T T′ and the lamp, that the former can be pointed in any direction whatever. Fig. 2 represents the diaphragm D when viewed through the eye-piece T′. Fig. 4 is a front view of the slide S S, shewn passing through the tube K K, from which the socket B has been removed. The spring Sp. engages in a little nick in the edge of S S, whenever one of the apertures comes centrally over the opal disc O. The number or figure corresponding to any aperture is marked near its corresponding nick, and is read off near Sp., whenever an aperture lies centrally over O. The apertures are graduated in size in such a manner that their areas are related to one another in the following manner. The first aperture is called a figured 1; the second aperture is one-half the area of No. 1, and is figured 2; the third aperture is one-fourth the area of No. 1, and is figured 4; the fourth aperture is one-eighth the area of No. 1, and is figured 8, and so on until the smallest aperture is reached, which is only one-two-hundreth the area of No. 1, and therefore is figured 200.

If the candle is burning and the lamp held upright, the opal disc O is illuminated and forms a source of light. This light, given out by O (taken as a whole) is as constant as that afforded by the standard candle, which is quite constant enough for the purpose in view.

It is evident that the quantity of light illuminating the white ring on the diaphragm D, or in other words, the actual intensity of the illumination of the white ring, depends upon the area of O exposed to view, that is, upon the area of the aperture in S S lying in front of O. If aperture 30 is in front of O, then it follows that the white ring is illuminated with one-thirtieth of the intensity with which it would be illuminated were aperture No. 1 centrally over O.

If the observing tube T T′ is directed towards any particular part of a photographic subject, the actinic light passing from that particular part shines through the coloured glass and through the hole in D, appearing to the eye placed at T′ as an uniform spot of blue light; uniform, because the lens *(e)* prevents any detail of the subject being visible.

To measure the intensity of this spot of light, the diaphragm slide S S is pushed up or down until the white ring on D

appears of the same brightness as the luminous spot. The number of the aperture in S S then in use is read off close to the point of the spring SP. If, for instance, the luminous spot and ring appear of equal brightness when aperture No. 1 is in use, then, the exposure required to register on the sensitive plate that part of the subject to which the tube T T′ is directed, being say 1 second, then it follows that if aperture 50 is needed to balance the brightness of spot and ring, then an exposure of 50 seconds will be required, since the brightness of the spot of light is only one-fiftieth of its brightness in the former instance. Thus the apertures in S S are numbered in direct proportion to the exposures required.

When the readings of the Photometer lie between 1 and 8 or so, the blue spot and white ring are so bright that their difference of colour renders it difficult and uncertain to decide when their luminosity is equal. In the higher readings, when the spot and ring are comparatively dim and subdued, their difference of colour is no obstacle to comparison. The object of the tapering V shaped aperture in the eye-piece, is to enable the observer to reduce the apparent brightness of spot and ring, without disturbing the *relation* of their luminosity, when the readings are in the numbers 1 to 8 or 15. If the pupil of the eye coincides more or less exactly with the small circle shewn surrounding the V aperture, then the maximum quantity of light from the spot and ring enters the eye. If, on the other hand, the pupil of the eye is moved towards the left, more or less into the position indicated by the small dotted circle, then it is evident that only that light passing through the narrow end of the V aperture enters the eye, and thus the spot and ring may, by moving the eye more or less to the left, be sufficiently reduced in brilliancy, for the difference of colour to be no longer a source of error in their comparison.

Before being in a position to practically use the instrument, the photographer must find out, either by calculation, or by application to the maker, the relation between the rapidity or light-admitting capacity of the various stops used with his lens. Some always use the same stop. Here no calculation is needed, except in comparing the rapidity of one lens with another. If he uses several stops, it will simplify matters if he numbers his stops in direct proportion to the exposures that they require, as the apertures in the diaphragm slide S S are numbered. Let the largest stop be called No. 1. In order to obtain the numbers for the others, the following method is perhaps the simplest. If a lens is small, let the diameters of the stops be measured carefully with a rule, having its inches divided into sixteenths or twentieths. If the lens is a larger one, then a rule divided to eighths of an inch will do. The diameter measure of each stop is taken and multiplied by itself, and the resulting number

is then divided into the diameter of stop No. 1, multiplied by itself.

The results severally represent the amounts of exposure for each stop when the exposure for No. 1 stop is called 1. For example, a set of 4 stops measure 20 sixteenths, 14 sixteenths, 10 sixteenths, and 6 sixteenths respectively. Then we have for Stop No. 1, 20 multiplied by 20 equals 400, &c.; or putting it in a tabular form, we have

Stop 1.	Stop 2.	Stop 3.	Stop 4.
20 × 20	14 × 14 = 196,	10 × 10 = 100,	6 × 6 = 36,
equals	and	and	and
400.	400	400	400
	divided by	divided by	divided by
	196	100	36
	equals 2 practically.	equals 4.	equals 11 practically

Thus, if the exposure for No. 1 stop is represented by 1, then exposure for No. 2 stop is 2, that required for No. 3 stop is 4, and that required for No. 4 stop is 11.

Then numbers 1, 2, 4, 11, are the *exposure numbers* of the set of stops. In such calculations great accuracy is simply superfluous.

As it is a general rule accepted by all photographers, that the exposures should be adapted to the shadows of the subject, since the high lights will take care of themselves; the Photometer is used for estimating the exposure necessary to register the details of the shadows on the sensitive plate. In a really good negative, all the detail in the shadows of the subject visible to the eye, should be represented, while any shadows of the subject so dark that *no* detail is visible (that is blank shadows that are natural, and not merely due to defective general illumination) should be represented by clear glass in the negative.

Therefore the true function of the Photometer is to measure the brightness of the *darkest visible detail* of the subject; the observing tube T T′ is directed towards such a part of the subject, and the Photometer reading is a measure of the exposure necessary to imprint that detail on the plate in a degree suitable to the taste of the photographer. Some photographers prefer the detail in the shadows printed much more decidedly in their negatives than others, who prefer more clear glass.

It has always been a great difficulty to photographers, especially beginners, to estimate the luminosity of the shadows of their subjects, and for several reasons, among which may be reckoned the varying brightness of the daylight, the situation of the subject, the time of day, and the varying size of the pupil of

the eye, which last factor causes the photographic value of a dull diffused light to be over estimated.

The patent Photometer renders the photographer independent of all these difficulties, and an exposure may be made after sunset or in a dark situation with the greatest confidence. He knows what he is about, and may over or under expose (for the shadows) just as he thinks best for the subject, and develop accordingly. Some subjects present such strong contrasts that a tendency to under expose for the shadows is necessary to the preservation of the high lights, while, in flat open subjects, decided full exposure for the darkest parts produces the most natural and faithful result. For the latter class of subjects, including much open landscape work, there is a great range of exposure permissible, consistently with good results, and the photographer may, as often as not, trust to his judgment unaided by any instrument, at any rate during the middle hours of the day.

The first thing necessary, before being in a position to use the Photometer for estimating exposures, is to make a few trials to ascertain the following points with regard to any particular brand of plate. The point to be ascertained is, what exposure is necessary to register shadow detail on the plate to a degree agreeable to the taste of the photographer, *when the Photometer reading for that detail is 1, and the stop used in the lens is No. 1.*

This is the "constant" for that brand of plate used with that particular lens. If in two or more lenses the same relation between the diameter of the largest stop and the focal length is present in all, then the same "constant" applies to all, provided the rapidity of the plate remains the same. The rapidity of lens remaining the same, then the "constant" will vary directly as the amount of exposure required for the plate, or as the slowness of the plate. One plate 3 times as slow as another, will require a "constant" 3 times as large, for a certain rapidity of lens. One lens 4 times as rapid as another, will require a "constant" just one fourth of the value of the "constant" necessary for the slower lens, for a certain rapidity of plate. If the photographer uses various lenses, he can ascertain their relative rapidity (with largest stop) by referring to the tables published in various hand-books, or by applying the simple calculations, of which they give examples. Then he has only to ascertain the "constant" for the lens he most frequently uses, in order to obtain the "constant" required for his other lenses.

The "constant" for a particular lens used with a plate of a certain rapidity, once being known, then, whenever a subject is to be photographed, and a photometer reading of the darkest visible detail has been taken, the correct exposure required is obtained by multiplying the Photometer reading by the

"constant," and the result again by the "exposure number" of the stop used in the exposure. For example, a subject in a dark situation is to be photographed. The Photometer reading is 50, and the exposure number of the stop to be used is 6, and the constant for the plate in use is $2\frac{1}{2}$ secs. Here then, the correct or normal exposure is 50 multiplied by $2\frac{1}{2}$ multiplied by 6, that is about 120×6, equals 720 secs. or 12 minutes.

Or, again, the Photometer reading is 15, and the exposure number of the stop to be used is 4, and the constant for the plate in use is $\frac{1}{5}$ of a second only. Here the correct exposure is $15 \times \frac{1}{5} \times 4$ or 3×4 or 12 secs.

To obtain the "constant" for a given brand of plate used with a certain lens, the photographer proceeds as follows :—

The camera is set up before any subject presenting the usual amount of contrast suitable to a good photograph. The more constant the daylight is, the better. Stop No. 1 is used in the lens, if the exposure is long enough to be reckoned in seconds; but if the subject is too bright for so much as a second's exposure with Stop 1, then a smaller stop necessitating much more exposure, is used. The candle in the Photometer is lighted and watched until the wax begins to melt around the bottom of the wick. The lamp is then closed, and the candle tube is grasped by one hand, and the lamp held as upright as possible, while the observing tube is directed towards the darkest visible detail of the subject. The slide S S is pushed up or down, until the blue spot and white ring are of equal, or as nearly as possible equal brightness, and the reading is taken near Sp. The lamp is at once opened, and the candle is extinguished. What is thought to be the right exposure is given, closely after taking the Photometer observation. If the exposure (in seconds) is divided by the Photometer reading, and the result again divided by the exposure number of the lens stop used, (that is, if other than No. 1 stop has been employed), a number or fraction is obtained, which is the "constant" that has been the basis (right or wrong) of the exposure. The plate is developed in the usual way adopted by the operator for a correctly exposed plate. If the "darkest visible detail" fails to come out properly, another trial must be made, giving an exposure with a larger "constant" as its basis. If, on the other hand, the "darkest visible detail" developes too readily, indicating over exposure, then another exposure is made, and a smaller "constant" assumed as its basis. After a few trials the correct exposure is hit upon, and the "constant" assumed as the basis of that exposure is accepted, at any rate provisionally.

For instance, at the first trial the Photometer reading is 15, and an exposure of 8 seconds has been given with No. 1 stop. The "constant" which is the basis of this exposure is 8 divided by 15, that is about $\frac{1}{2}$ second. The exposure is found to be

much too small, and a "constant" of $1\frac{1}{2}$ seconds, or 3 times as much, is taken as the basis for the next exposure. The Photometer reading taken before the second exposure is now perhaps 30, owing to a decline in the light. Here then an exposure of $1\frac{1}{2}$ times 30, or 45 seconds is given (for Stop 1.), and found to be about correct, and $1\frac{1}{2}$ seconds is accepted as the "constant," perhaps to be further modified as the experience of the photographer suggests.

To take another example, where the lens is a rapid one, and the exposure number of the stop used is 8, and the first Photometer reading is 20, and the first trial exposure is 10 seconds. The "constant" which is the basis of this exposure is 10 seconds divided by 8 times 20, that is 10 divided by 160, that is $\frac{10}{160}$ equals $\frac{1}{16}$th second. The plate is developed, and the darkest visible detail comes out too readily, so a constant of only $\frac{1}{30}$th second is assumed for the next exposure, when the Photometer reading is perhaps 12, the light being brighter. The second exposure then is $\frac{1}{30}$th second multiplied by 12 multiplied by 8, that is $\frac{96}{30}$ths, which equals $3\frac{1}{5}$th seconds, or about 3 seconds. If, on developing, the exposure is found still too much, then a further diminution of the constant is made until the right constant is hit upon. All the above which takes so much description to make clear on paper is, when once understood, easy in actual practice.

There is supplied with the Photometer a cap carrying a piece of dark glass, shewn at C under the candle tube, on the end of which it screws when not in use. It is designed to screw into the cap carrying the coloured glass in the end T of the tube T T′, and for the purpose of largely reducing the light from the detail examined by the Photometer, so that observations may be taken of the darkest parts of brilliantly illuminated subjects, which are otherwise so bright as to be beyond the power of the instrument to measure. In a very sunny climate or on a very bright day, it will be found very useful for some subjects. It obviously necessitates a smaller "constant" when in use. The required "constant" may be easily ascertained, if the "constant" for the instrument used without the dark glass is known. The simplest way by which a sufficiently near approximation is obtained, is to have a sheet of white cardboard illuminated by nothing else than a good gas burner, which may be trusted to remain of constant illuminating power for some time. The Photometer, without the dark cap, is directed towards the cardboard, and by means of adjusting the distance of the gas jet and of directing the instrument to varying parts of the cardboard, an *exact* reading of 1, 2, 4, or 8 is obtained, then the observed part of the cardboard is marked. If necessary, the instrument is allowed to cool, and then the dark cap is screwed on and the candle relighted, and a fresh observation

taken of the marked spot on the cardboard, care being taken that the relative positions of the latter and of the gas jet remain the same as before. The first reading divided by the second reading gives a fraction which expresses the relative amount of light admitted by the dark glass to that admitted by the coloured glass alone. The normal "constant" is multiplied by this fraction and the dark glass "constant" is obtained. For instance, the first reading is 4 and second reading is 30, or a trifle more, say 32. Here 4 divided by 32 equals $\frac{4}{32}$ equals $\frac{1}{8}$. If then the normal "constant" is $\frac{1}{5}$th second, then the dark glass "constant" is $\frac{1}{5}$th second multiplied by $\frac{1}{8}$th, that is $\frac{1}{40}$th of a second.

Or again, the first reading is 8 and second reading 50. Here 8 divided by 50 equals $\frac{8}{50}$, or say $\frac{8}{48}$, that is $\frac{1}{6}$th. Therefore the dark glass "constant" is about $\frac{1}{6}$th of the normal constant. If the latter is 2 seconds then the former will be $\frac{1}{3}$rd of a second.

Precautions, &c.

The wick of the candle should on no account be snuffed or interfered with. In the diagram it is shewn in its normal burning state, like an inverted hook. The candle should be pushed upwards now and then from the bottom of the tube, so that the point where the wick enters the wax is kept about flush with the top edge of the candle tube.

Each standard candle is about 10 inches long, and can be cut up into 3 or 4 parts with a hot knife. Then some of the wax is cut away at one end of each piece to expose the wick. After being allowed to burn until the end of the wick curls over and becomes red hot in the edge of the flame, it is ready for use. When a candle is inserted in the candle tube, a strip of soft paper is first wrapped round it so that the candle fits tolerably tight within the tube, and can be pushed upwards whenever necessary.

In taking an observation, the lamp should be shut up as soon as the wax round the wick begins to melt, and the eye should be placed at the eye end immediately, so that it may have as much time as possible to get accustomed to the comparative darkness within the tube. The reading should be taken within about two minutes after lighting the candle, or the lamp will grow so hot that the candle is in danger of melting away. A little experience will soon teach the observer how long it is safe to allow the candle to burn. Two minutes at the most is ample time for an observation, which ought to be taken just before the exposure.

The eye should be applied as closely as possible to the eye end, in order to exclude side-light. As long as the same part of the subject is observed, which is selected from the position of the camera, it is immaterial whether the observer stand close to the camera or not, or nearer than the camera to the observed part or not. Therefore the observer can, in many cases, select a

stand-point, which is more sheltered from the wind and sunshine. than the camera. By so doing, an observation is made much easier. As a general rule, however, if it is too windy to use the Photometer, it is too windy for photography.

It is most important that the lamp should be held *upright*, and so grasped by the candle-tube, that the air inlet passage underneath is not in any degree obstructed by the hand.

It is also most important that the candle should, immediately after an observation, be put out by means of the *small extinguisher* supplied with the lamp. It should be held over the wick until all smouldering ceases, after which the observing tube is turned down parallel to the lamp, and the Photometer hung up to the camera stand by the ring in the small chain attaching the extinguisher to the lamp. A screw or stud must be fixed in the tripod head for that purpose. It must hang vertically until the wax of the candle has set again.

The Photometer should be examined from time to time, to see that the air holes are not obstructed either by wax or soot, any of which should be cleaned off. To get at the air outlet holes, the top cap or hood of the chimney is unscrewed, and to get at the air inlet holes, the three screws marked P are unscrewed, and the cap F F pulled off. If now the screw g is unscrewed, then the inner casing of the lamp may be withdrawn, in case any melted wax has penetrated between the two casings and cemented them together. This may happen if the candle has been allowed to burn too long at a time. Before the inner casing can be withdrawn, the lamp must be heated, and then the wax be cleaned off both casings with benzine or other such solvent. The opal disc O may be taken out for cleaning by withdrawing the socket B and the slide S S when it will drop out, or can be pushed out from within the lamp.

In taking an observation, the figures marked on the slide S S need not be strictly adhered to for the readings, as for instance, it may be difficult to decide whether aperture 50 or aperture 100 causes the blue spot to be most nearly matched. In this case a number half way between 50 and 100, or 70, ought to be taken for the reading.

Towards or after sunset the daylight is relatively deficient in the *non*-visible chemical rays of which the instrument takes no account. This is sometimes the case in broad day when a marked yellow tint is noticeable in the light. In such cases the exposures indicated by the Photometer should be increased 50 per cent. or more. It must not be forgotten that there is a certain amount of latitude even in the exposures calculated to give first class results. In spite of this fact the majority of negatives are wrongly exposed, and it is to render this evil impossible in careful hands that the Photometer has been specially designed.

Addendum.—The dark glass constant may generally be taken as being about one-twentieth part of the normal constant.

The Photometer may be utilized for estimating exposures when copying drawings, engravings, paintings, &c. In such cases an observation may be taken, in the usual way, of the darkest or least actinic parts and the usual constant (at least) be used, or the constant may require increasing to counteract the lengthening of the focus of the lens consequent upon the nearness of the object to be copied. Or, if there is no shadow or dark part of the engraving, &c., forming a feature definite enough to be observed, as is the case with outline drawings, then an observation of the whites or high lights may be taken, and the constant (whether it is the dark glass constant or otherwise) be multiplied 20 or more times as the basis of the exposure, since it is obvious that the high lights of the object must receive much more exposure than any shadow detail in order to develop with sufficient density in the negative. For such subjects, to be copied indoors, or by artificial light, or in situations new to the experience of the photographer, the Photometer will be found useful. In regular studios, however, the photographer is able, owing to his experience under nearly constant conditions and to his power of regulating the light, to time his exposures with correctness without the aid of any photometer, although he may be glad to avail himself of it at times when the light is exceptionally dull.